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DATA LINKAGE : STRATEGIES USED BY THE LABORATORY ON TRANSPORTATION SAFETY OF THE CENTRE FOR RESEARCH ON TRANSPORTATION (CRT) OF THE UNIVERSITÉ DE MONTRÉAL IN ITS ROAD SAFETY RESEARCH

by

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ABSTRACT

Articles on road published in scientific journals often reveal the linking of data from existing files, the most common example being the user of driver's licence master files linked to involvement in accidents and violations. Licence numbers make other types of data linkage possible.

In Canada, the provinces and the federal government have developed numerous administrative records that list variables for entire populations. These contain data that offer much potential for valid road safety research with respect both to the assessment of existing measures and to the study of risk factors, provided the data are usable for research purposes. Research findings can facilitate better planning and the development of preventive policies and administrative measures that can control and reduce needless deaths and injuries on the roads. Transport Canada, through the Road Safety Data Management Steering Committee, is therefore trying to combine the various initiatives taken by jurisdictions in Canada by requesting reports from the organizations involved, among them this report on data linkage.

The CCMTA (Canadian Council of Motor Transport Administrators) is involved in efforts to standardize driver's licence, motor vehicle registration and other data, which are discussed at federal-provincial meetings.

In Quebec, the Société de l'assurance automobile du Québec (SAAQ) supplied a considerable quantity of records for our research. Established by the National Assembly in 1978 as the Régie de l'assurance automobile du Québec (RAAQ), the SAAQ has legislated responsibility for road safety. It insures victims against bodily injury caused by moving motor vehicles. The SAAQ is also responsible for the regulation and administration of driver's licences, motor vehicle registration, licence suspensions and demerit points; it receives all traffic violation reports and police reports on road accidents in Quebec.

The SAAQ has made its data available for research and for data linkage, in accordance with ethical rules. This open-door approach has led to frequent exchanges between the SAAQ, particularly its Research and Analysis Service, Transport Québec and other researchers, which have had a twofold benefit: first, the SAAQ has the advantage of more accurate records, increasingly detailed reports and planning and decision making based on analysis of facts and assessment of safety measures, and second, researchers have been able to undertake original research, based in many cases on entire populations.

Members of the Laboratory on Transportation Safety of the CRT have extensive experience in the linking of data from varied sources. Having successfully completed many such exercises over the last 25 years, they have produced original research findings in the field of road safety, have been able to exploit large databases representing the entire population of Quebec, and have devised successful solutions for problems of data confidentiality. Our research focuses on groups, rather than individuals, but we do need personal data for various types of analysis and models that will produce valid results. As we shall show in citing various projects, we also used data from sources other than the SAAQ, such as the health insurances board (the Régie de l'assurance-maladie du Québec – RAMQ), studies initiated by our own team, and private firms.

Selection of data sources depends on the subject of the research and the working hypotheses. In chapters 2, 3, 4, 5 and 6, we present examples of the use of linked data in relation to the intitial variables. Thus, chapter 2 deals with information on drivers, licences, violations, and SAAQ

medical records. Chapter 3 relates data on health, injuries, health status according to the RAMQ with those in manuscript and computerized hospital records, and chapter 4 deals with vehicles as the initial variable. Chapter 5 covers collisions, type of vehicle, type of collision, and location of collision. In chapter 6 we discuss how we compensated for missing data with specific surveys. We conclude in chapter 7 with a discussion of the challenges involved in linking administrative data, the various owners of data and the rules of confidentiality, quality, and technical considerations.

Key words : Data linkage, road safety, administrative files, population records, surveys.

RÉSUMÉ

Les publications d'articles sur la sécurité routière dans des revues scientifiques témoignent souvent d'une utilisation de jumelage de fichiers existants dont les plus fréquents sont par exemple l'utilisation de fichiers maîtres des permis de conduire reliés aux implications dans les accidents et aux infractions. Le numéro de permis permet d'autres types de jumelage.

Au Canada les provinces et le gouvernement fédéral ont développé de nombreux fichiers administratifs qui enregistrent des variables sur des populations entières. Ces fichiers contiennent des données qui ont un grand potentiel pour effectuer des recherches valables en sécurité routière, soit par l'évaluation de mesures mises en place, soit pour étudier des facteurs de risque à la condition que ces données soient utilisables pour fin de recherche. Ainsi les résultats de recherches pourront faciliter une meilleure planification, la mise en place de politiques de prévention et d'administration de mesures pouvant réduire et contrôler les décès et blessures inutiles causées par le transport routier. C'est pourquoi Transports Canada, par le Road Safety Data Management Committee, demande des rapports aux différentes instances, notamment le présent rapport sur le jumelage de données.

Le CCATM (Conseil canadien des administrateurs en transport motorisé) tente d'effectuer des travaux de standardisation des données de permis de conduire, d'immatriculation de véhicules motorisés et autres, travaux discutés lors de rencontres fédérales-provinciales. Au Québec, la Société de l'assurance automobile du Québec (SAAQ) a fourni pour nos recherches un nombre considérable de fichiers. Établie par l'Assemblée Nationale en 1978 sous le nom de Régie de l'assurance automobile du Québec (RAAQ), la SAAQ a un mandat de sécurité routière par la loi. Elle assure les victimes de la route pour les dommages corporels subis à cause d'un véhicule moteur en mouvement. La SAAQ est aussi chargée de la réglementation et de l'administration des permis de conduire, des immatriculations des véhicules, des révocations de permis, des points d'inaptitude; elle reçoit tous les rapports d'infractions, et ceux de la police sur les accidents de la route au Québec.

La SAAQ a rendu ses données jumelables et disponibles pour la recherche, selon des règles d'éthique. Cette ouverture a provoqué de nombreux échanges entre la SAAQ particulièrement leur Service d'études et analyses, Transports Québec et les chercheurs, ce qui d'une part a favorisé pour la SAAQ des fichiers plus précis avec des bilans statistiques annuels de plus en plus développés et une prise de décision et de planification basée sur des faits analysés et sur l'évaluation des mesures de sécurité. D'autre part les chercheurs peuvent entreprendre des recherches originales souvent basées sur des populations entières.

Des membres du Laboratoire sur la sécurité des transports du Centre de recherche sur les transports possèdent une vaste expérience dans le jumelage de données provenant de diverses sources. Ayant réussi depuis 25 ans un grand nombre de tels jumelage, ils ont obtenu des résultats originaux de recherche dans le domaine de la sécurité routière, ont pu exploiter des fichiers considérables qui représentaient toute la population du Québec et ils ont aussi résolu avec succès les problèmes de confidentialité des données. Nos recherches s'intéressent à des groupes d'individus et non pas à des individus comme tels. Cependant nous avons besoin de données personnelles qui permettent divers types d'analyses et de modélisation qui conduisent à des résultats valables. Nous avons aussi utilisé d'autres sources de données que celles de la SAAQ, comme nous l'illustrerons en donnant l'exemple de divers projets, que ce soit celles de la Régie de l'assurance-maladie, des données d'enquêtes initiées par notre équipe ou celles générées par des compagnies privées.

Le choix de la source des données dépend de la problématique du sujet de recherche et des hypothèses émises. Dans les chapitres 2, 3, 4, 5 et 6 nous présentons des exemples d'utilisation d'informations jumelées à partir des variables de départ. Ainsi le deuxième chapitre porte sur l'information sur le conducteur ou la conductrice; permis de conduire, infractions, fichier médical de la SAAQ. Le troisième chapitre relate les informations sur la santé, blessures, statut de santé selon la RAMQ et selon les dossiers manuscrits des hôpitaux et ceux informatisés, et le quatrième chapitre porte sur les véhicules comme variable de départ. Le cinquième chapitre porte sur les collisions, type de véhicule, type de collision, lieu de la collision. Au chapitre 6 nous discuterons comment nous avons comblé des données manquantes par des enquêtes spécifiques. Nous terminerons au chapitre 7 par une discussion sur les défis que posent les jumelages de données administratives, les divers propriétaires de données et les règles de confidentialité, la qualité et les considérations techniques.

Mots clés : Jumelage de données, sécurité routière, fichiers administratifs, données de populations, enquêtes.

ACKNOWLEDGMENTS

We wish to thank Transport Canada, particularly Bill McCauley and Glenn Robbins, who prompted the preparation of this paper. We also wish to thank Denise Desjardins and Stéphane Messier, who revised our manuscript; our publications are evidence of a deeply appreciated collaboration in our research work. Over the last 25 years of research carried out by the Transport Safety Laboratory (LST) of the Transport Research Centre (CRT), we are much indebted to our colleagues Robert Bourbeau and Georges Dionne, and to André Viel and Claude Dussault of the Research and Analysis Service of the SAAQ. Claudine St-Pierre contributed her splendid skills and professionalism to the meticulous transcription of our report.

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1. INTRODUCTION

Members of the LST of the CRT have extensive experience in the linking of data from varied sources. Having successfully completed many such exercises over the last 25 years, they have produced original research findings in the field of road safety, have been able to exploit large databases representing the entire population of Quebec, and have devised successful solutions for problems of data confidentiality. This has led Transport Canada to give us a two-stage mandate to describe our experience. The first stage is the production of an annotated outline, leading to a second stage in which the authors will produce a final report at the end of June 2000 describing and illustrating the types of data and linking techniques our team has used in our road safety research.

Articles on road safety published in scientific journals often reveal the linking of data from existing files, the most common example being the use of driver's licence master files linked to involvement in accidents and violations. Licence numbers make other types of data linkage possible. For example, Barnie Jones, 1994, was able to assess the impact on road safety of the introduction of provisional licences for drivers aged 16 and 17 in Oregon in October 1988, using files from a time series giving the results of BMV driving tests. Leon Robertson, 1980, also used files containing variables that generated a quasi-experimental design showing that high school driver education programs had a perverse effect in that they enabled drivers to obtain a licence at an earlier age, thus increasing accident rates.

In Canada, the provinces and the federal government have developed numerous administrative records that list variables for entire populations. These contain data that offer much potential for valid road safety research with respect both to the assessment of existing measures and to the study of risk factors, provided the data are usable for research purposes. Research findings can facilitate better planning and the development of preventive policies and administrative measures that can control and reduce needless deaths and injuries on the roads. Transport Canada, under the leadership of Bill McCauley, is therefore trying to combine the various initiatives taken by jurisdictions in Canada through the Road Safety Data Management Steering Committee, formed in 1997, and by requesting reports from the organizations involved, among them this report on data linkage and that of Montufar J. et al, 1999, which describes existing databases in Canada

and the limitations on their potential for data linkage; the authors also describe their experience as engineers in studying accident locations and highway data.

The CCMTA (Canadian Council of Motor Transport Administrators) is involved in efforts to standardize driver's licence, motor vehicle registration and other data, which are discussed at federal-provincial meetings.

The British Columbia Insurance Corporation has developed CCC (Crash, Crime, Contravention) and the RCMP are working on the IPIRS concept: Integrated Police Information Reporting System. Quebec's automobile insurance corporation, the SAAQ, is working on a new project: STARS, for Inter-jurisdictional Feasibility Study of a System for Technological Applications in Road Safety. This series of applications includes a complete system for collecting and reporting road incidents that works in conjunction with the integrated justice system. For example, accident site data is collected electronically and is available to potential users provincewide. STARS is now the subject of a feasibility study to determine whether it can be introduced and applied elsewhere in Canada.

The SAAQ supplied a considerable quantity of records for our research. Established by the National Assembly in 1978 as the Régie de l'assurance automobile du Québec (RAAQ), the SAAQ has legislated responsibility for road safety. It insures victims against bodily injury caused by moving motor vehicles. The SAAQ is also responsible for the regulation and administration of driver's licences, motor vehicle registration, licence suspensions and demerit points; it receives all traffic violation reports and police reports on road accidents in Quebec. Other provinces have developed universal car insurance schemes, but Quebec is the only one that combines an insurance system with the administration of licences, vehicle registration and so on, and promotes road safety research by providing funding in conjunction with Transports Québec and the FCAR (Fonds pour la formation de chercheurs et l'aide à la recherche). The SAAQ has made its data available for research and for data linkage, in accordance with ethical rules. This open-door approach has led to frequent exchanges between the SAAQ, particularly its Research and Analysis Service, Transports Québec and other researchers, which have had a twofold benefit: first, the SAAQ has the advantage of more accurate records, increasingly detailed reports and planning and decision making based on analysis of facts and assessment of safety measures,

and second, researchers have been able to undertake original research, based in many cases on entire populations.

Our group had begun studies based on linked data before the establishment of the SAAQ. In fact, one of our first studies, which in 1976 looked into road injuries (mortality and morbidity), medical care in Quebec and accident circumstances, was based on a combination of four sources of data from the third-party liability service (STR) of Quebec's health insurance board, the Régie de l'assurance maladie du Quebec. This administrative service, established under hospital insurance legislation in 1961 and health insurance legislation in 1970, recovered from private insurers the funds disbursed by the government on behalf of people responsible for accidents. It was abolished in 1978 when the SAAQ was set up, and handled all accidents in which a third party was liable. Its manuscript files on road accident victims included the following documents:

1. The accident report prepared by the police.
2. The hospitalization report (AH-101), which provided information on the nature of the injury or injuries (assessed according to the 1975 AIS scale of severity, and the ISS), the type of medical treatment, and the duration and cost of hospitalization. Form AH-85 also provided data on emergency and out-patient care.
3. A record of medical care provided by a physician in hospital, in an out-patient clinic or in a doctor's office, and the cost of these services, obtained from computerized health insurance files.
4. An STR questionnaire completed by the victim or his or her family, which provided additional information on the circumstances of the accident and on the medical treatment provided.

This study yielded:

a) A finding of 20% under-reporting of highway injuries in police reports in 1974, more pronounced in the case of persons injured but not hospitalized.

b) A breakdown of injuries, their severity and the direct costs of treatment, which were particularly high in the case of pedestrians and motorcyclists.

c) An analysis of the characteristics of road accident injuries in relation to the circumstances of the accident, using correspondence analysis (Benzecri).

d) A demonstration of the importance of developing analytical tools compatible with this new approach based on the linking of data from various sources that could lead to further research and to new strategies to prevent traumas due to highway accidents.

For further information on this study, see:

BOURBEAU Robert, LABERGE-NADEAU Claire, LATOUR R., MAAG U., "Road crashes and injuries in Quebec (1974): Patterns among many variables", Accident Analysis and Prevention, Vol. 13, No. 4, pp. 349-355, 1981.

LABERGE-NADEAU Claire, BOURBEAU Robert, GRANGER Jean, "Mortalité et morbidité due aux accidents de la circulation routière, projet-pilote : étude des victimes ayant reçu des soins médicaux suite à un accident de la route, Quebec 1974", Rapport de recherche pour le Ministère de la Santé nationale et du Bien-être social, juin 1978. [Mortality and morbidity due to traffic accidents – pilot project: study of victims given medical treatment after a traffic accident, Quebec, 1974, research report for the Department of National Health and Welfare, June 1978]

BOURBEAU Robert, LABERGE-NADEAU Claire, "Road Injuries in Quebec (1974): Nature, Severity and Direct Costs", Proceedings of the 21st AAAM Conference, September 1977.

LE BOURDAIS Céline, LABERGE-NADEAU Claire, BOURBEAU Robert, "Pedestrian Injuries and Medical Treatment", Proceedings of the 24th AAAM Conference, October 1980.

BOURBEAU, Robert, "Les accidents de la route au Quebec 1926-1978 - Étude démographique et épidémiologique" [Road accidents in Quebec 1926-1978 – Demographic and epidemiological study]. Collection "Démographie canadienne" 7, Les Presses de l'Université de Montréal. 424 pp., 1983.

As our study went to press, the RAAQ (Régie de l'assurance automobile du Quebec), which in 1990 became the Société de l'assurance automobile du Quebec (SAAQ), was established in March 1978 and subsequently integrated with the Bureau des véhicules automobiles (BMV). Because of our 1976-78 project, we saw the possibility of access to much more complete data with the advent of the RAAQ.

Thus, for almost 25 years, our research team – consisting then of professors Robert Bourbeau, Urs Maag and Claire Laberge-Nadeau has carried out a number of studies, many of them using linked data. As we shall show in citing various projects, we also used data from sources other than the SAAQ, such as the health insurance board (the Régie de l'assurance-maladie du Québec – RAMQ), studies initiated by our own team, and private firms.

Our research focusses on groups, rather than individuals, but we do need personal data for various types of analysis and models that will produce valid results.

Selection of data sources depends on the subject of the research and the working hypotheses. In chapters 2, 3, 4, 5 and 6, we present examples of the use of linked data in relation to the initial variables. Thus, chapter 2 deals with information on drivers, licences, violations, and SAAQ medical records. Chapter 3 relates data on health, injuries, health status according to the RAMQ with those in manuscript and computerized hospital records, and chapter 4 deals with vehicles as the initial variable. Chapter 5 covers collisions, type of vehicle, type of collision, and location of collision. In chapter 6 we discuss how we compensated for missing data with specific surveys. We conclude in chapter 7 with a discussion of the challenges involved in linking administrative data, the various owners of data and the rules of confidentiality, quality, and technical considerations.

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Robertson L.S., Crash involvement of teenaged drivers when driver education is eliminated from school. *Am J Public Health*, 70: 559-603, 1990.

Montufar J., Clayton A., Mruss K. Issues relevant to the strategy of linking databases for use in road safety research. Final draft submitted to Transport Canada. 47 pp., June 1999.

2. DRIVER INFORMATION

We shall proceed project by project, from the most recent to the oldest.

2.1 Driver's licence

The driver's licence has always been the initial variable for studies of new drivers, and this file was also the basis for the project on cellphones. We present six research projects that began with subject selection based on the driver's licence. More than 85% of the population of Quebec aged 16 or older holds a driver's licence.

2.1.1 Title: Les téléphones mobiles/cellulaires et le risque d'accidents [Cellphones and accident risks]

Authors: Claire Laberge-Nadeau, Urs Maag, Robert Bourbeau, François Bellavance, Sophie Lapierre, Denise Desjardins, Stéphane Messier, Isabelle Morin

Objectives

The main objective of the project is to make an epidemiological study of matched cohorts focussing on the association between cellphone use while driving and road accidents, distinguishing between accidents involving bodily injury and those involving material damage only. We shall be able to check whether drivers with access to a cellphone have more (or fewer) accidents than those who do not. We shall then be able to determine whether use of a cellphone while driving does or does not increase the accident risks for users, and whether there are other variables (higher-risk general behaviour, and so on) that may explain the number of accidents.

Data linkage

- Driver's licence holders

  Recruitment of volunteers using an SAAQ mailing of letters of introduction and authorization and a questionnaire to 175,000 licence holders matching our specifications, which yielded a study based on 38,265 respondents, 13,643 with a cellphone and 24,622 without.
- 4 years of accidents

- 4 years of violations, suspensions and demerit points
- 4 years (or 2 years) of mobile phone use data from 4 companies providing cellphone services.

Strategies

The project is under way. Results will be available in December 2000 if all the data come in by September 2000. Seven databases will have to be linked in order to conduct the analyses that will enable the objectives to be met.

This is a complex project requiring a substantial investment. Every private company has its own procedures and its own way of keeping records. In preparation for our research, we carried out a feasibility study, and the cooperation of the companies involved was assured with the help of the Canadian Wireless Telecommunications Association (CWTA). A pilot study of 1,000 licensed drivers was also carried out, before the main study, to test the various procedures for acquiring data from the SAAQ and from mobile telephone service providers.

After numerous meetings and telephone discussions with Roger Poirier and Carrie Moussa, respectively President and Vice-President of the CWTA, and with representatives of the four telephone companies (Bell Mobility, Cantel AT&T (subsequently Rogers AT&T), Clearnet and Fido/Microcell), we had to modify the initial data acquisition protocol. We had planned to recruit cellphone subscribers directly using an insert mailed with their monthly accounts. The companies routinely include advertising with the account. Because this procedure, which would have been economical for us, affected their subscribers, the companies' lawyers advised against it. We would then have matched these volunteers with volunteers without a cellphone. Since this method of recruiting volunteers directly was not acceptable, it was agreed at this point in the project that users and non-users would be recruited through a sample of licence holders based on SAAQ data, with the collaboration of Claude Dussault and the support of the SAAQ management.

This is the first epidemiological study of cellphones in actual driving that looks at their involvement in total accidents, and accidents causing injuries (which necessitates a large sample), using two matched cohorts.

Reference

LABERGE-NADEAU C., MAAG U., BOURBEAU R., DESJARDINS D., MESSIER S., CÉDRAS L., Les téléphones cellulaires et le risque d'accident: faisabilité d'une étude épidémiologique. Rapport final présenté au FCAR. Février 1998. [Cellphones and accident risk: feasibility of an epidemiological study – final report submitted to the FCAR, February 1998]

2.1.2 ***Title: Étude comparative des risques d'accidents des nouveaux conducteurs selon qu'ils aient suivi ou pas un cours de conduite et ce, en accordant une attention particulière à la propension à prendre des risques*** [Comparative study of new drivers' accident risks, according to whether they took driving lessons or not, with special attention to their risk-taking propensity]

Authors: Urs Maag, Claire Laberge-Nadeau, Georges Dionne, Denise Desjardins, Stéphane Messier, Pierro Hirsch

Objectives

i. To compare new drivers' accident rates during probation, depending on whether they had taken a driving course or not.

ii. To identify the risk-taking propensity of new drivers using a psychometric test.

iii. To verify whether there is an association between the propensity to take risks, and accidents and violations.

Data linkage, strategy and method

Subjects were recruited in three SAAQ service centres in the Montreal area that administer tests and issue probationary licences to those who pass the practical test. The project focussed on brand new drivers under 20 years of age who were asked to complete a questionnaire on education, psychological characteristics related to the propensity to take risks, and family, social and economic background. We also requested authorization to obtain their driving record from the SAAQ for their first year of driving with a probationary licence. Data from the questionnaire

will be linked to information to be provided by the SAAQ, including accident and violation data, and possibly with replies to a second survey of the participants, planned towards the end of their first year of driving.

The project is designed to enable calculation of accident rate ratios so as to compare the two groups (with and without driving lessons) taking into account psychometrics, exposure to risk and other control variables. We are thus planning to produce a bank of individual data on slightly more than 3,000 people.

This project is under way. Initial results will not be available before the end of 2000, and the rest will follow in 2001.

2.1.3 ***Title: Le lien entre la performance aux examens (théorique et pratique) pour l'obtention d'un permis et le taux d'implication dans les accidents.*** [The link between performance on theoretical and practical licence tests, and the rate of involvement in accidents]

Authors: Claire Laberge-Nadeau, Urs Maag, Robert Bourbeau, Denise Desjardins, Stéphane Messier, Pierro Hirsch

Objectives (Part I)

To check whether there is a link between individuals' licence test results and their subsequent involvement in traffic accidents (rate of involvement).

Data linkage, strategy and method (Part I)

The target population consists of all the individuals in Quebec who took the first steps to obtain a class 5 (automobile) licence between March 1, 1991 and February 28, 1993. On March 1, 1991, a graduated licensing system was introduced, whereby applicants have to pass a theoretical test to obtain a learner's permit, wait at least 90 days to take a driving test, and wait a further 28 days after failing any test. The main dependent variable is the number of accidents in each of the three

years after obtaining a licence (thus data from accident records). Other useful variables are available from violation, suspension and demerit points data. The main independent variables are test performance data: number of attempts at each of the three parts of the theory test, and number of attempts at the practical test.

Linking of data for this project (on licences, tests, accidents and violations) was done in conjunction with the SAAQ, and generated a database on 149,585 individuals.

For the purposes of this project, we added the following conditions: no other licence apart from the class 5 (passenger vehicle); probationary licence obtained (and therefore practical test passed) before the end of 1993; active file at the end of 1996 (three-year driving record); not more than 90 days of licence suspension (penalty or delayed renewal). These conditions reduced the population to 111,533 individuals (58,464 women and 53,069 men) with a record of individual data.

In our statistical analyses, we used negative binomial regression models with random effects for all accidents (three observations over time for each subject).

Results

There is a reduction in the accident rate over three years for all age and gender groups. Individuals who pass their tests at the first attempt have fewer accidents than those who have to try more than once. This is generally true for both genders and all age groups. The connection is strong in the case of the theory test (all three parts), but minimal for the practical test. Longer learning periods are also associated with lower rates.

We encountered familiar results according to gender, with men having almost twice as many collisions as women, and according to age, those 20 or older having significantly lower rates than the 16-year-olds. We were unable to obtain the risk exposure for this population of new drivers. Our results for the link between test results and accident rates confirmed those of an earlier project (see 2.1.4).

Additional analyses were made of accidents with injuries using logistic regression. Finally, individuals with more than 90 days of interruption of licence validity were studied separately: they have accident rates (total, and with injuries) substantially higher than those without prolonged interruption.

Objective (Part II)

To identify current (and possible future) elements of the tests offering the best indication as to subsequent involvement of drivers in accidents.

Data linkage, strategy and method (Part II)

The population is made up of individuals who reported for their first attempt at the theory test at service centres offering computerized tests in the busiest months between June 1992 and July 1996. The dependent variable is the number of accidents during the first year of driving. The key independent variable is the overall mark for the theory test, expressed as the ratio of the number of correct answers to the number of questions. To pass the theory test, candidates must pass all three parts. The pass marks are:

Part 1 on the highway code: 12 correct answers out of 16;

Part 2 on signs: 12 correct answers out of 16;

Part 3 on class 5: 24 correct answers out of 32.

Other independent variables are the version of the questionnaire used (there are 15 versions), and the number of attempts to pass both tests (theory and practical).

The SAAQ had prepared a special file for us by linking the theory test subfile, containing each applicant's answers to each question, with the file for accidents during the first year following the obtaining of a licence; this file contains 91,851 individuals.

To build a file of comparable individuals, the initial file had to be modified to select only those individuals for whom it contained the first attempt at the theory test, and who had passed the tests before December 31, 1996, for whom the driving record existed for an entire year following

the obtaining of a licence, and who held only a class 5 (passenger car) licence. After these adjustments, the file contained 50,667 individuals: 25,180 women and 25,487 men.

For our statistical analyses, we used negative binomial regression models for the accidents, adding the version of the theory test used, the combination of parts passed at the first attempt, and the overall mark as additional independent variables.

Results

Those who passed the theory test with a higher mark, at the first attempt or later, have a lower collision rate than those with lower marks. Results by gender, age group and duration of learning period are the same as for part I.

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LABERGE-NADEAU C., MAAG U., BOURBEAU R., DESJARDINS D., MESSIER S., HIRSCH P. Le lien entre la performance aux examens (théorique et pratique) pour l'obtention d'un permis et le taux d'implication dans les accidents. Rapport final présenté à la SAAQ. Août 1999. [The link between performance in licence tests (theory and practice) and involvement in accidents. Final report submitted to the SAAQ. August 1999.]

2.1.4 Title: Analyse de l'effet des nouvelles règles d'obtention d'un permis de conduire (1991) sur la sécurité routière [Analysis of the impact of new (1991) licensing rules on road safety]

Authors: Georges Dionne, Claire Laberge-Nadeau, Urs Maag, Robert Bourbeau, Denise Desjardins and Stéphane Messier

Objective (Part I)

The effect of the new rules on the accident rate, from a comparison between a "before" cohort and an "after" cohort.

Data linkage, strategy and method (Part I)

The new rules created an obligation to hold a learner's permit for at least 90 days, after passing the theoretical knowledge test, and to take a driving course of twelve 55-minute lessons (8 or 10 of 60 minutes before the change).

The population includes all the individuals who began the driver's licence process between March 1, 1989 and February 28, 1993 (two years before and two years after the changes), a total of 399,543. The dependent variable is the number of accidents (with date) during the first year of licensed driving. This file was built by the SAAQ by linking the licence file, indicating the date of entry into the system (before versus after) and adding the number of attempts at the tests, and the accident file. We considered 12 periods of 30 days. For each period, we established a dichotomic (or 0-1) variable indicating whether the individual had an accident or not. To allow for changes in economic conditions, we assigned to each person and each period the monthly employment rate (expressed as the person's risk of being unemployed, their actual status being, of course, unknown) by age and gender, as well as monthly sales of regular gas in Quebec (source: Statistics Canada).

For this objective, we had to eliminate individuals who did not obtain a licence before December 31, 1993, those who did not have a driving record for 365 days after receiving their licence, and those who also had a motorcycle licence. These conditions reduced the SAAQ file to 220,467 individuals.

The statistical analyses applied logistic regression models for panels (accident or no accident during 12 periods of 30 days) using the GEE (generalized estimating equations) method, and negative binomial regression models for accidents during 365 days.

Results (Part I)

Our results indicate that the changes introduced in 1991 had no direct effect on accident rates for new drivers in all age groups. However, some indirect effects were found, including a new and

unexpected result: passing the theory test at the first attempt reduces accident rates for men and women. Passing the practical test the first time is not linked significantly to different rates for those who have to try more than once. The experience accumulated while holding a learner's permit is accompanied by a lower accident rate, particularly for males and females aged 16, and females aged 17. The marginal effect on accident rates shows that new male drivers aged 20 or over and new female drivers aged 17 or over are less at risk than males and females aged 16.

Objective (Part II)

Evaluation of the effects of the changes on licences issued (anticipation, age, time until licencing) using a database covering 11 years.

Data linkage, strategy and method (Part II)

The population consists of the 1,115,288 individuals who were issued their first driver's licence in Quebec between January 1, 1985 and December 31, 1995 with the dates for the learner's permit and for the regular or probationary licence (SAAQ licence data). To allow for economic conditions, we added Statistics Canada data on the Quebec population by age and gender, annual unemployment rates by age and gender, annual sales of regular and premium gasoline, and gross domestic product.

Results (Part II)

The rates of issue of initial licences were calculated on the basis of the population by age group and gender. We found a large drop in licences issued in 1991, particularly to 16-year-olds, due to the changes in the regulations and the economic crisis that occurred in the same year. There had been anticipation of the changes, in the form of an increase in learner permits issued of about 10,000, during the two months preceding the changes. For the period after, there was a slight increase in the time until licencing (time with the learner's permit), but a drop in average age at the time the licence was issued. It was the drop in the number of new drivers that had a beneficial effect on the health of the population: we estimated an annual drop of 3,500 accidents for the

period 1992-93 by comparison with 1989-90, following the 31% drop in new licences in 1991, compared with 1990.

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2.1.5 Title: The effects of age and experience on accidents with injuries: Should the licensing age be raised?

Authors: Claire Laberge-Nadeau, Urs Maag and Robert Bourbeau

Objectives

To study the effects of age and driving experience in order to assess their respective contributions to the rate of accidents with injuries.

Data linkage, strategy and method

The SAAQ has assembled a file listing all Quebec class 5 (passenger car) licence holders, with the age at which they acquired their first licence, for the period 1971 to 1984. It was linked to the file for accidents with injuries occurring between 1979 and 1984. This file lists 1,958,231 individuals. To calculate the rate of initial licence acquisition, we used Statistics Canada data on the population of Quebec by age group and gender. The ages used were 16, 17, up to 24 by age year, and then by age groups: 25-34, 35-44, 45 or over. Driving experience at the time of the accident was dichotomized: less than a year versus a year or more.

The statistical analyses included simple regression models of accident-with-injuries rates as a function of age, separately for the two driving-experience groups and each gender.

Results

Trends in acquisition rates show that new drivers – male and female – tend to be considerably younger. Accident rates fall with age for both driving-experience groups (less than a year versus a year or more), both having very similar accident-with-injuries rates, and those under 20 having the highest rates. These rates are much lower for females than for males, regardless of age.

Reference

LABERGE-NADEAU C, MAAG U., BOURBEAU R. The effects of age and experience on accidents with injuries: Should the licensing age be raised? Accident Analysis and Prevention, Vol. 24 No. 2 April 1992, pp. 107-116.

2.1.6 ***Title: Évaluation de l'impact sur la sécurité routière de la loi du Québec (1983) qui rend obligatoire le cours de conduite pour tout nouveau conducteur.*** [Evaluation of the impact on road safety of the 1883 Quebec law making driver training mandatory for all new drivers]

Authors: Louise Potvin, François Champagne, Claire Laberge-Nadeau

Objectives

To evaluate the effect on accidents and initial driving age of the 1983 Quebec law requiring every new driver to take an approved driving course before he or she can be issued a driver's licence.

Method

Using an interrupted time series and the ARIMA models, four indicators were developed:

- Accident and accident-with-injuries risk in the first year of driving;
- Mortality/morbidity rate per accident involving at least one driver during his or her first year of driving;
- Number of new drivers;
- Average age when licence issued.

The group selected for study consisted of new drivers aged 18 or over; the comparison group consisted of new drivers aged 16 or 17, who were not affected by the new law: since 1961, in Quebec, 16-year-olds had been required to take driver training, a requirement extended to 17-year-olds in 1976.

Monthly reports were forwarded by the SAAQ between 1980-82 (36 months) and from January 1, 1983 to August 1984 (20 months) indicating:

- The number of new drivers, average age by gender and age;
- The number of accidents and accidents with injuries involving at least one of these drivers in the first year of driving, by gender, age and experience, 0 to 6 months and 7 to 12 months, and the type of vehicle (only private vehicles were included).

Strategies

In order to produce the aggregate population data (including all new drivers) needed for this research, the SAAQ records had to be organized so as to link accidents and driver's licences in order to extract the data to produce monthly reports on the variables needed for this research.

Results

The law making driver training mandatory that came into force on January 1, 1983 in Quebec had no appreciable effect on accident risk or death or injury rates per accident for new drivers aged 18 or over. However, since 1983 the number of new female drivers aged 16 or 17 has increased 20% and the average age has fallen; this may have increased the number of accidents involving young people, particularly young female drivers.

In the wake of the results of this research and after a study of the various reliable publications on the subject, the requirement to take a driving theory course was abolished on March 1, 1991.

Reference

Potvin L., Champagne F., Laberge-Nadeau C. Mandatory Driver Training and Road Safety: The Quebec Experience. *American Journal of Public Health* 1988; 78: 1206-1209.

2.2 Violations

In most of our studies, violations are a dependent variable, or a variable that characterizes a driver. The way in which SAAQ records are currently organized makes it possible to obtain this

variable attached to the driving record for driver's licences. Thus, it is not an initial variable, as we proposed for our illustration on data linkage. We shall encounter this variable again in various research examples.

2.3 SAAQ medical records

The requirements for driving a motor vehicle are defined by the law, which obliges class 5 drivers to declare any illness, and professional drivers (classes 1-2-3-4A-4B-4C, tractor-trailer, bus, straight truck, emergency vehicle, minibus, taxi) to undergo medical and ophthalmic examinations to acquire or renew their licence at certain ages; the same is required of the elderly (70 or older when this research was done; it is now 75 in Quebec). This legislation results in a special treatment of licences and the establishment of a file of medical records by the SAAQ.

2.3.1 Title: Impact sur la sécurité routière des normes médicales et optométriques pour la conduite d'un véhicule routier. [Impact on road safety of medical and optometric standards for drivers of road vehicles]

Authors: Laberge-Nadeau C., Dionne G., Maag U., Desjardins D., Messier S., Ekoé J.-M., Joly P., Hamet P., Nadeau J.M., Gagnon R.

Objectives

This program includes six lines of research: the impact on road safety of 1) diabetic truck drivers (classes 1 and 3); 2) bus drivers (classes 2 and 1) with coronary insufficiency or hypertension; 3) class 5 drivers aged 70-85 and taxi drivers (class 4C) with vision problems; 4) a study of underreporting of medical conditions; 5) a survey of risk exposure for 20,206 holders of class 1, 2, 3, 4B, 4C and 5 licences; and 6) studies of RAMQ data. There was also an in-depth study of diabetic drivers. This is therefore a wide-ranging project that required a series of preparatory studies.

Data sources and linkage

- SAAQ medical records:
  - Diabetics
    - Treated with diet;
    - Treated with diet and oral hypoglycemic drugs;
    - Treated with insulin.
  - Vision problems
    - Acuity (various levels);
    - Binocular vision;
    - Visual field.
  - Coronary insufficiency: several categories
  - Hypertension: several categories
  - Good health and normal vision: matched cohort
- Driver's licence: age, gender, class
- Involvement in accidents over 4 years
- Telephone survey on risk exposure
- RAMQ data on all subjects in the study group (linkage 97.5% successful) in order to check a) state of health in each year, and b) co-morbidity.

Data from these sources were used to construct an anonymous base of individual rather than aggregate data.

Method

This is a study of two cohorts, one with medical conditions and one with good health and normal vision, using a hybrid scheme that is both retrospective and prospective.

Comparative analyses by age level of the average number of accidents a year for the groups with medical conditions versus the "healthy" group were conducted using Poisson or negative binomial models in order to simultaneously incorporate independent variables for: a) all licence holders; b) respondents to the questionnaire; c) non-respondents to the questionnaire;

d) respondents who said they drove a vehicle as part of their job, labelled "professional drivers" for classes 1 to 4C; and finally e) all respondents who said they did not drive as part of their job or who did not have a job (unemployed, retired or other occupations), labelled "non-professional drivers". In the last two cases, the regression models simultaneously include exposure-to-risk variables.

Results

Our analyses of diabetes mellitus show that class 1 truck drivers with diabetes that is not treated with insulin and is without complications have twice as many accidents with a truck as their healthy counterparts in the 46-55 age group, whereas non-professional drivers of the same age who are not treated with insulin, and have complications, have an accident risk rate 2.46 times higher than the matching healthy group. For class 3 drivers, an interesting result emerged for those with diabetes without insulin and without complications, aged between 46 and 55, who have on average 3 to 5 times more accidents than the matching healthy control group, depending on whether they were professional or non-professional drivers, truck drivers, or respondents or non-respondents to the questionnaire. This group also had more accidents involving bodily injury. For class 5, the accident risk is 2.41 higher for female drivers aged 21-25, and 2.8 times lower for male drivers under 20 with type 1 diabetes, compared with their counterparts the same age. For the age 68-86 cohort, female drivers aged 68 to 75 with diabetes have 2.5 times as many accidents as those who are in good health, and 2.2 times as many as diabetic male drivers aged 81-86.

Our results indicate no statistically significant difference, using a 10% threshold, for class 1 or class 3 truck drivers with coronary insufficiency or hypertension. For class 4B, professional drivers with these conditions have higher rates than their counterparts.

Results with respect to minimum visual standards of class 5 drivers are not statistically significant in terms of the number of accidents a year involving female drivers between 68 and 86 years old with acuity or visual field problems, compared with their healthy counterparts. Among male drivers aged between 68 and 75, those with 20/50 & 20/100 or 20/200 vision and those with 20/40 & 0 vision have, on average, 62% and 36% more accidents, respectively, than

their age counterparts in good health. No significant difference is observed at the 5% level for class 4C taxi drivers. Class 3 truck drivers, however, who have to meet the same minimum requirement for visual function as those in class 4C, include at least one group with binocular vision problems – those aged 35 or younger – who have 2.5 times as many accidents as their matching control group. Note that the average accident rate is about twice as high among taxi drivers (30.6 accidents per 100 drivers per year) than it is for class 3 truck drivers (14.3 accidents per 100 drivers per year), regardless of medical condition.

Strategies

Given the complexity of the research program, we cannot list all the preparatory studies undertaken to determine such things as the quality of the data, or the classification of the various medical conditions with specialists in endocrinology, cardiology and ophthalmology, or the innumerable steps taken to conclude administrative arrangements and agreements. For example, our arrangements with the RAMQ took a year to work out, so that we could link the data while complying in full with the rules respecting confidentiality. The SAAQ-RAMQ linkage showed that of the truckers in good health in 1987, 13% were no longer well in 1990 (4 years of follow-up). Among those aged 70-85, it was almost 50%. Our analyses had to take this into account.

State of health was defined first according to the SAAQ's internal codes, which indicated the pathology and treatment of the diseases studied, and then by matching the RAMQ's ICD-9 codes for diagnosis and the RAMQ's internal codes for medical procedures. This linkage improved the quality and validity of the state-of-health data. We were able to build a unique research file which, in conjunction with our analyses, produced a number of original findings, as shown in the last article published in the journal *Diabetes Care*.

This is useful research from several points of view. With respect to the knowledge gained, it is well known that an assessment of the possible role of various medical conditions in the occurrence of accidents or highway code violations has never been carried out under proper research conditions. The obstacles we encountered were numerous, since it is difficult to establish a causal relationship given the many variables – apart from a medical condition – that can have a concurrent impact on the occurrence of an accident. The professional classes of

drivers are subject to the strictest driving rules; research prior to ours dealt mainly with passenger vehicles.

This research is cost-effective. A conservative calculation based on just two of our findings shows that if class 3 truck drivers who are diabetics without insulin and without complications reduced their accident rate to match that of their healthy control group, and if the same hypothesis were applied to binocular vision, cost savings of the order of $12,425,370 (in 1992 Canadian dollars) would be realized. This entire research program cost less than one-twelvth of that amount. The details of this calculation are given in a report. We have not included an estimate on the other results of our research that have an impact on the public and on the issuance of licences by the SAAQ. The spin-offs within Canada and beyond are also substantial. Other organizations, researchers and administrators have contacted us to obtain our findings. The doctors that prepare medical examination reports for the SAAQ have also shown great interest in our results.

In social terms, regulations have an impact on individuals who seek to acquire a driver's licence. Licensing regulations exist in all Canadian provinces and all American states, but they differ greatly, for lack of scientific evidence on which to base them. In the political arena, polemics are frequent: the Supreme Court of Nova Scotia ruled in favour of an insulin-dependent diabetic, allowing him to drive a tractor-trailer and quashing a provincial regulation. Under NAFTA, efforts are being made to standardize US and Canadian regulations on truckers' licences. The Canadian Charter of Rights can also have an impact on the regulations. In the US, the 1990 Disabilities Act also affects the regulations of the Federal Highway Administration (FHWA). Research results can help ensure the necessary fairness for drivers and road users by better defining the ability to drive safely.

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5. HEALTH INFORMATION

Information on health and injuries is found in various databases and handwritten documents.

a) Handwritten records

In hospitals with or without a trauma centre, and in emergency rooms, handwritten records are kept of all road accident injuries treated. Many hospitals maintain a unique file on every patient admitted, or treated in emergency or as an out-patient. Others, however, do not, and this can make the collection of research data a laborious process. In hospital records, descriptions of the circumstances that led to injury are often sketchy, and this is why trauma centres request police reports on road accidents. For epidemiological studies and even in clinical work, it is important to relate the circumstances of the accident (the force of the impact, the body area affected) and the resultant injuries. Case studies can be useful with this kind of manual data linkage, but the number of cases is often small, since trauma centres handle serious, multiple-trauma cases. Clinical notes accompanied by x-ray, scanner, biochemical and other test results, and OR observations, add details on diagnosis and the short-term progress of the patient. The police report is a semi-public document and can be useful if linked to the admitting record, especially if the report includes the name of each accident victim, the medical insurance number and the hospital he or she was sent to. For additional information about the impact, detailed reports prepared by engineers provide explanations that police reports cannot include, but such reports cover only a very small proportion of the cases in which hospital records are consulted. Researchers can use a variety of data sources, depending on their field of inquiry.

For example, a University of Montreal student working on a master's in public health studied the progress of trauma cases over a 2-year period when the Trauma Centre was established at Sacré-Coeur Hospital in Montreal; she used summary sheets and handwritten records in the hospital's archives.

b) Database on hospitalization summary sheets

When a patient is released, however, a summary sheet (form AH-101 in Quebec) must be completed, computerized and sent to the Ministère de la santé (department of

health) or the RAMQ. The resultant database can be used to track all road accident injury victims hospitalized in the province and derive variables such as ICD-9 or ICD-10 injury diagnoses and the E-codes, which provide a breakdown by type of accident; the summary sheet also lists the patient's condition on release, operations, length of stay with admitting and release dates, geographical region, and so on.

c) Database on emergency and out-patient services

These are insured services, and provincial health departments take them into account for payment and reimbursement to the hospitals. In Quebec, form AH-85 is sent to the department and the resultant database records visits, but it is not now possible to extract individual patient data.

d) Database on medical procedures and some laboratory tests at the RAMQ

These records list all procedures for which physicians and optometrists in the province were paid, regardless of whether they were done in the practitioner's office, in emergency, in hospital, in an out-patient clinic or in the patient's home. The account sent to the RAMQ contains summary demographic data on the patient, ICD-9 or ICD-10 coded diagnoses, consultation dates and other information, but not lab test results. We worked with the RAMQ for our study of the "impact on road safety of medical and optometrical norms". The RAMQ agrees to process these data when required for research purposes, provided the processing cost is reimbursed and provided the research targets groups of beneficiaries and not individuals; data are transmitted in anonymous form. Before we can forward our research specifications, numerous preliminary feasibility studies and pilot projects must be carried out. When the linkage was performed with driver's licence records, for the study cited in 2.3, we hoped to obtain a 70% linkage, but we achieved 97%.

e) Handwritten insurance company records

These contain medical reports and the company's correspondence with an injury victim. In Quebec, a provincial corporation - the SAAQ – insures and compensates all road accident victims. Some information is extracted and computerized, but the handwritten reports provide better information on the nature of injuries and patient progress, and even the handwritten police report gives more information than the computerized file, and this

makes it possible to verify the computerized data. We had to refer to it for our study of the effectiveness on injury of wearing seat belts (see 5.1).

3.1 Injuries

3.1.1 Title: Neck injuries amongst motor vehicle occupants involved in a collision

Authors: Claire Laberge-Nadeau, Xiang-Tong Tao and Urs Maag

Objectives

To characterize the occupants of passenger vehicles suffering at least one cervical injury who were involved in a motor vehicle accident in Quebec in 1987.

To quantify the duration and cost of compensation their injuries entailed for neck injury victims.

Data linkage, strategy and method

The SAAQ prepared a special codification of injuries (up to seven) suffered by collision victims in 1987, using the International Classification of Diseases (ICD-9). It linked the compensation file (duration of hospitalization, the various costs, and so on) with the accident file (circumstances, use of seatbelt), and the weights of the vehicles involved were added from the vehicle registration file. The working file contained 4,328 individuals who had suffered at least one neck injury.

Using a conversion program developed by E. MacKenzie of Johns Hopkins University, we converted the ICD-9 codes into Abbreviated Injury Scale (AIS-85) rankings.

Results

Sprains are the most frequent neck injuries (92%). Women have a higher risk (40%) of neck injury than men, but men suffer more severe injuries. The total of all amounts paid out by the SAAQ for victims of neck injuries alone was more than $10 million for accidents occurring in

1987, the largest sum being allocated to income replacement. Note that direct medical costs are covered by the RAMQ.

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4. VEHICLE INFORMATION

4.1 Title: L'évaluation du risque d'accident des transporteurs en fonction de leur secteur d'activité, de la taille de leur flotte et leur dossier d'infractions [Assessment of the accident risk of trucking companies according to sector of activity, fleet size and record of violations]

Authors: Georges Dionne, Denise Desjardins and Jean Pinquet

Objectives

To develop ways of assessing the accident risk of trucking companies. The model was also to:

1. Identify the sectors in which problem companies were active;
2. Measure the effect of fleet size on a trucking company's risk level;
3. Identify delinquent behaviours linked directly to safety risk levels.

The goal in fact was to verify how sector of activity and fleet size can affect trucking companies' risks.

Data linkage, strategy and method

This was a study of a population based on vehicles (trucks and buses) for the year 1995-96. The starting point was the list of trucking companies dated July 23, 1997, which identifies owners and long-term lessees of one or more eligible vehicles with an identification number, and it is thus possible to track the vehicles belonging to a given company. However, the number may change when one company merges with another, or when files are paired as a result of an administrative decision, and a vehicle may be sold to another company. A major step in the process was to devise a single usable identification number, as one company could have up to 28 different numbers. Using the identification number, we obtained the operating licences of all eligible vehicles, as well as information on each vehicle. The plate number enabled us to link each vehicle with the accidents and violations committed by its driver, as well as the violations for which the company was responsible (excess loads, mechanical faults and the like). The list of trucking companies also provides information on each company.

Building the research file was a substantial task, undertaken jointly by the SAAQ and the LST. The diagram below shows the complex linkages between the various files. After checking the start and end dates for each company against the start and end dates for vehicle operating licences for 1996, the research file contained 143,744 vehicles belonging to 52,662 trucking companies.

For half the vehicles, the kilometrage was estimated from the odometer reading. Criteria were developed to retain only usable observations.

Our statistical analyses used multiple regression models for discrete (or count) variables.

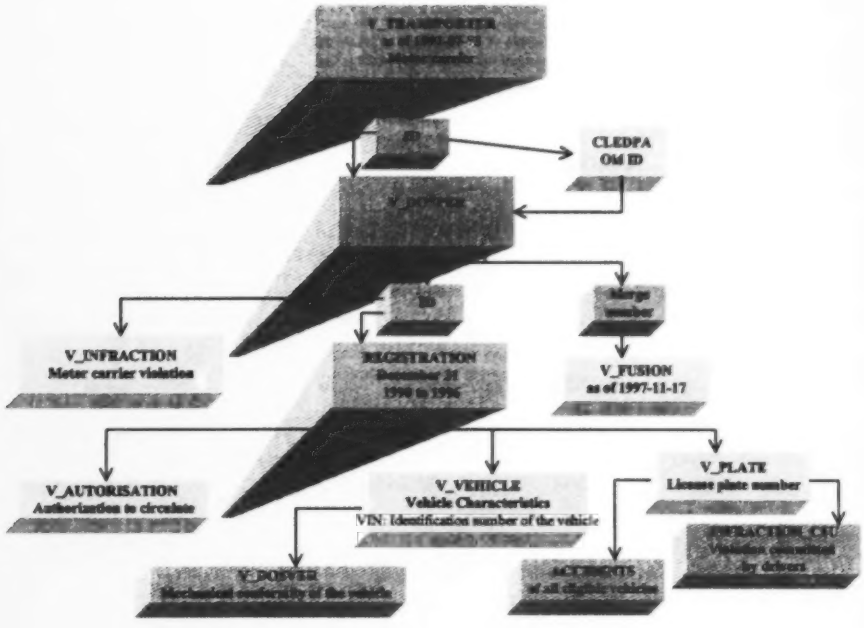

Figure 1: Links established between SAAQ databases

Results

Controlling for risk exposure (kilometrage at mechanical inspections), we found no one sector of trucking activity that was riskier than others. Without this variable, the sectors General Merchandise Transport and Short-term Rental Companies have higher risks than Bulk Transport, while the group of Independent Truckers shows no statistical difference.

Two trucking company violations are important in explaining total accidents: excess loads and failure to carry out a mechanical inspection. All highway code violations studied (speeding, driving while suspended, failure to stop at a red light, a stop sign or a police officer's signal, failure to wear a seat belt) are significant in explaining total accidents, whereas only speeding and seatbelt violations are significant for those involving death and injury. The larger fleets have more accidents than the small ones.

For buses, only failure to stop at a sign or an officer's signal are significant in explaining total accidents, when exposure to risk is taken into account. Fleet size is not a significant factor.

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5. COLLISION INFORMATION

5.1 ***Title: La ceinture de sécurité: efficacité, analyse des lésions corporelles et comparaison de modèles de ceinture*** [Seat belts: effectiveness, injury analysis and comparison of various kinds of belt]

Objectives

- To compare injuries (nature, area affected, and severity) suffered by belted and unbelted front-seat occupants in similar accidents, and to make the same comparison for different types of collision and different vehicle weights
- To compare injury severity for various models of seat belts, in belted victims.
- To demonstrate the use of government data in evaluative road safety research.

Method

Evaluative research based on data we assembled that covered all accidents occurring between March 1, 1978 and December 31, 1981 in which at least one person submitted a claim to the RAAQ. The database covered all front-seat occupants of the vehicles involved, and was constructed by combining the RAAQ claim file and the corresponding police reports that identify the base population. Verification of the quality of the computerized data preceded the linkage process and the selection of samples (Laberge-Nadeau et al., 1984). There is a tendency to minimize the effort required in these operations, which are essential when making evaluations based on secondary administrative data.

Here is a summary of the conclusions from our study of the quality of secondary data from the RAAQ: 1) the data on trauma are not all usable in their computerized form, but this problem can be corrected by improving data capture procedures; 2) some accident data are of good quality (vehicle type and weight, or position of occupants in the vehicle, for example) and can be used without reservation. Others require enrichment through consultation of the handwritten version (parts of the vehicle where damage occurred, for example).

In order to evaluate and compare the number and severity of injuries to belted and unbelted occupants, and to isolate the effectiveness of belt use in actual accidents, allowances must be made for certain variables that can have an effect, together with the seat belt, on the severity of injuries. We therefore put together a number of homogeneous occupant-accident groups.

In the first stage of homogenization, in order to eliminate the less measurable impact forces, a selection was made on the basis of certain accident characteristics: for example, only those accidents that had no second occurrence were included. Accidents involving trucks, buses, taxis and emergency vehicles were excluded. Of accidents involving a collision, only two-vehicle and single-vehicle accidents were included.

Second, we looked into which variables we could identify among the external factors mentioned above. These are as follows:

HOMOGENEOUS OCCUPANT-ACCIDENT GROUPS

Variables suggested	**Variables used (X)** U of M research
1. Deceleration (Δv)	1. First level of homogenization and indicator = zone speed limit
2. Deceleration time (γ_{mean})	2. Speed limit
3. Vehicle weight	3. X
4. Type of impact	4. X (2 vehicles)
5. Intrusion	5.
6. Type of impact	6. X (1 vehicle)
7. Occupant's role (that is, position in the vehicle)	7. X
8. Age	8. X
9. Gender	9. X
10. Weight of the occupant	10. X (height)

The indicator we used for force of impact is the "zone speed limit". It is crude, admittedly, but it allows us to differentiate between two groups by speed zone.

The creation of homogeneous accident-occupant groups was based on the following four factors:

- Zone speed limit (2 classes)
- Vehicle mass (4 classes)
- Two-vehicle accidents: type of impact (5 classes)
- Single-vehicle accidents: type of accident (3 classes)
- Occupant's role: (2 classes: driver or front-seat passenger)

Thus, our population consisted of front-seat occupants only.

Breaking down the data into the various classes based on these four factors allowed us to constitute 192 groups. Among the groups of similar accidents, we identified 53 of the most numerous groups. Data was obtained from the handwritten file for each claimant in the final sample in order to specify injury diagnosis and check other variables against the accident sketch prepared by the police officer.

Our sample thus included 11 groups of occupants involved in single-vehicle accidents, and 42 groups of occupants involved in two-vehicle accidents. These occupants may be broken down as follows:

Table 15: Breakdown of accident victims in the sample by type of accident and whether belted or unbelted, front-seat occupants, Quebec, 1978-1981.

Type of accident Use of seat belt	Belted	Unbelted	Total
Two-vehicle accidents	7,886	3,827	11,713
Single-vehicle accidents	554	580	1,134
Total	8,440	4,407	12,847

Note that individuals whose use or non-use of a seat belt was not specified in the police report were excluded, which reduced the sample by about 13%. Also, our sample included some 8% of accidents with injuries occurring in Quebec during the period in question. It is not representative, however, but consists of a specific and clearly identified portion of the whole.

Nature and severity of injuries

Each of the ICD-9-coded injury diagnoses taken from claimants' handwritten files was re-coded using the AIS (Abbreviated Injury Scale, 1980 version). To characterize the injuries suffered by each victim in our sample, the MAIS (major AIS) and the ISS were compiled. The MAIS was used in our analyses, as it enabled us to compare our findings with those of various contemporary publications.

Our research base was assembled using the following:

Insurance claim

Accidents – police reports, linked with the following:

Driver's licence of the person driving

Vehicle registration

Claimants' handwritten medical records

A number of variables were extracted from these sources (a list is appended to the report).

We calculated an index of effectiveness that is the negative of the fraction attributable to belt use.

Results

Our research shows the effectiveness of seat belts as presented summarily in tables 16 and 17. Table 17 is to be interpreted as follows: if unbelted front-seat occupants in two-vehicle collisions had been wearing a seat belt, 69% would have avoided death, 38% serious injury, 6.6% minor injury, and 7.4% would have avoided injury altogether.

Table 16: Breakdown of victims (%) by severity of injury - 2 vehicles

MAIS	0	1-2	3-4-5	6	TOTAL (sample size)
ALL[1]					
Belted	67.1	29.9	2.6	0.4	100 (7,886)
Unbelted	62.5	32.0	4.2	1.3	100 (3,827)
DRIVERS[2]					
Belted	68.5	28.8	2.3	0.4	100 (5,372)
Unbelted	63.8	30.4	4.1	1.6	100 (2,267)
FRONT-SEAT OCCUPANTS[3]					
Belted	64.2	32.2	3.3	0.4	100 (2,514)
Unbelted	60.6	34.2	4.2	1.0	100 (1,560)

1) $\chi^2_{(3)} = 67.61,\ p < 0.001$

2) $\chi^2_{(3)} = 57.78,\ p < 0.001$

3) $\chi^2_{(3)} = 11.59,\ p < 0.010$

Table 17: Index of seat belt effectiveness (%) - 2 vehicles

MAIS	0	1-2	3-4-5	6
ALL	+7.4	-6.6	-38.1	-69.2
DRIVERS	+7.4	-5.3	-43.9	-75.0
FRONT-SEAT OCCUPANTS	+5.9	-5.8	-21.4	-60.0

A number of other analyses were carried out on the injuries suffered by vehicle occupants. For example, use of a seat belt increases trauma to the cervical area in various kinds of impact, not just rear-enders.

Strategies

This research project was particularly laborious because computer equipment of the 1981-84 period did not offer the performance it does now, and the RAAQ's records at that time were not as well organized as the SAAQ's are now. Following are some thoughts (Laberge-Nadeau et al., 1988) expressed in the report submitted to the SAAQ with respect to the third objective. This result can be found in the appendix (summary results table) and in the article cited.

Following are some thoughts on the computerized files maintained by a government agency. It seems to us that once the decision has been taken to computerize, the process should be carried out with care, using quality controls and regular evaluations since, even at the administrative and political levels, concrete action results from the analysis of the data. An important aspect of the process is the writing-up and coding of procedures, bearing in mind that staff turnover can be high in a government agency. Collaboration between such an agency and the researchers who use the data is an aid to quality control. The researcher/agency interaction can yield improvements in existing databases at low cost. This will give us databases containing secondary data that will be

more and more usable by researchers, and more and more accurate for administrative decision makers.

The RAAQ, which is a young and progressive agency, has been most cooperative and open in its dealings with researchers, and the fact that it designed from the outset a sophisticated computerized system that it continues to develop through systems analysis is a sign of its very open-minded approach.

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APPENDIX: THE EXAMPLE OF PROJECT 5.1

- Results by types of impact
- Variables used in research

ANNEXE F

RÉSUMÉ DES RÉSULTATS DE L'ANALYSE DES LÉSIONS CORPORELLES CHEZ LES CEINTURÉS ET LES NON-CEINTURÉS

F.1 Victimes d'accidents à deux véhicules (MAIS)

Région corporelle de la blessure principale		Type d'impact I			II			III		IV			V	
		E	C	PA	E	C	PA	E	C	E	C	PA	E	C
Tête	A	CN	CN	CN	CN	CN	CN	CN	CN	CN	CN	CN	CN	CN
	B	NS	+	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Visage et tissus mous du cou	A	CN	CN	-	-	CN	-	CN	CN	CN	CN	CN	CN	CN
	B	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Colonne cervicale	A	-	-	-	-	-	-	-	-	-	-	-	-	CN
	B	+	NS	NS	NS	NS	NS	+	+	-	NS	NS	NS	NS
Thorax	A	CN	CN	CN	CN	CN	CN	CN	CN	CN	CN	CN	CN	CN
	B	+	+	+	+	+	NS	NS	NS	-	-	+	NS	NS
Abdomen	A	+	-	CN	CN	CN	CN	CN	+	+	-	CN	CN	CN
	B	+	+	NS	+	+	NS	NS	NS	NS	+	NS	NS	NS
Colonne dorso-lombaire	A	CN	CN	-	-	CN	-	CN	+	CN	CN	-	CN	CN
	B	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Membres inférieurs et la ceinture pelvienne	A	CN	CN	CN	CN	CN	CN	CN	CN	CN	CN	CN	+	+
	B	NS	NS	NS	NS	NS	NS	+	NS	NS	NS	NS	NS	NS
Membres supérieurs et la ceinture scapulaire	A	CN	CN	CN	CN	CN	CN	CN	CN	CN	CN	CN	+	CN
	B	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Khi-deux calculé $\chi^2_{(7)}$		49[1]	38[1]	23[2]	33[1]	17[3]	25[4]	34[1]	35[1]	37[1]	35[1]	17[5]	25[6]	17[7]

I : collisions impliquant deux véhicules
II : collisions contre un véhicule plus lourd
III : collisions contre un véhicule plus léger
IV : collisions frontales (latérales)
V : collisions arrières
A : répartition topographique de la blessure principale
CN : contribution négligeable au Khi-deux
\+ : contribution marquée au Khi-deux; effet positif du port de la ceinture
\- : contribution marquée au Khi-deux; effet négatif du port de la ceinture
B : gravité de la blessure principale selon la région anatomique
NS : non significatif ($p > 0,05$)
\+ : effet positif du port de la ceinture ($p < 0,05$)
\- : effet négatif du port de la ceinture ($p < 0,05$)
E : ensemble des occupants avant
C : conducteurs
PA : passagers avant
1 $p < 0,00001$
2 $p < 0,0020$
3 $p < 0,0147$
4 $p < 0,0004$
5 $p < 0,0170$
6 $p < 0,0002$
7 $p < 0,0202$

B.1 Fichier d'étude

Type d'enregistrement	Provenance 1=1ère partie 2=2e partie 3=Calculée	Variable	Position de gauche	Longueur (en caractères)	Type N=numérique X=alphanumérique
1	1	D1001 Numéro de réclamation	1	7	X
1	C	D1034 Espace libre	8	1	N
1	1	D1003 No ass. maladie	9	8	X
1	C	D10030 Signe	17	1	X
1	C	D1003A Âge à l'accident	18	2	N
1	C	D1003B Sexe	20	1	X
1	1	R1001 Taille (conducteur)	21	3	X
1	1	D1004 Genre d'indemnité	24	1	X
1	1	D1005 Accident de travail	25	1	X
1	1	D1010 État civil	26	1	X
1	1	D1028 Code municipal réclamant	27	4	X
1	1	D1011 Code occupation réelle	31	4	X
1	1	D1012 CIM principal	35	4	X
1	1	D1013 CIM secondaire 1	39	4	X
1	1	D1014 CIM secondaire 2	43	4	X
1	1	D1016 Code préjudice esthétique	47	4	X
1	1	D1017 Taux préjudice esthétique	51	5	N
1	1	D1018 Code def-anato-physio	56	4	X
1	1	D1019 Taux def-anato-physio	60	5	N
1	1	D1022 Code douleur	65	4	X
1	1	D1023 Taux douleur	69	5	N
1	1	D1024 Date enregistrement	74	6	N
1	1	D1029 Nbre jours indemnisés	80	5	N
1	1	D1030 Date décès	85	6	N
1	1	D1031 Date début incapacité	91	6	N
1	1	D1032 Date fin incapacité	97	6	N
1	C	D1033 Nbre jours incapacité	103	4	N
1	1	D2001 Numéro évènement	107	15	X
1	1	D2002 Numéro microfilm	122	9	X
1	1	D2003 Code municipal accident	131	4	X
1	1	D2004 Numéro route	135	4	X
1	2	R2013 Catégorie de route	139	2	X
1	2	R2014 Localisation	141	2	X
1	1	R2006 Date accident	143	6	N
1	1	R2007 Jour accident	149	2	X
1	1	D2008 Heure accident	151	2	X
1	1	D2011 Genre accident (1er évènement)	153	2	X
1	1	D2012 Environnement	155	1	X
1	1	D2015 Croquis	156	2	X
1	2	R2020 Version dommages	158	1	X
1	1	D2016 Vitesse autorisée	159	3	X
1	1	D2009 Nombre morts	162	3	N
1	1	D2018 Nombre blessés graves	165	3	N

8.1 Fichier d'étude

Type d'enregistrement	Provenance 1=1ère partie 2=2e partie 3=Calculée	Variable	Position de gauche	Longueur (en caractères)	Type N=numérique X=alphanumérique
1	1	D2019 Nombre blessés mineurs	168	3	N
1	1	D2021 Nombre sans blessures	171	3	N
1	1	D2010 Nombre de véhicules	174	3	N
1	1	D2022 Nombre de conducteurs	177	3	N
1	1	D2023 Nombre de passagers	180	3	N
1	1	D2024 Nombre de piétons	183	3	N
1	1	D2025 Nombre autres personnes	186	3	N
1	2	D4010 No partie du réclamant	189	2	X
1	2	D4011 No fonction du réclamant	191	1	X
1	2	D4012 Code index du réclamant	192	1	X
1	C	D5001 Nombre de type 2	193	2	N
2	1	D3001 Numéro de partie	1	2	X
2	1	D3002 Genre d'accident (2ème évènement)	3	2	X
2	2	R3003 Sens avant impact	5	1	X
2	2	R3004 Mouvement du véhicule	6	2	X
2	1	D3005 Type véhicule	8	2	X
2	2	R3009 Marque véhicule	10	5	X
2	2	R3010 Année véhicule	15	2	X
2	1	D3007 Immatriculation	17	7	X
2	1	D3007A Année immatriculation	24	2	X
2	1	D3008 Province immatriculation	26	3	X
2	1	D3011 Poids net ou total A	29	6	X
2	2	R3012 Poids net ou total B	35	6	X
2	2	R3013 Poids net ou total C	41	6	X
2	1	D3014 Cylindre	47	1	X
2	2	R3015 Remorquage	48	1	X
2	2	R3016 Montant dommages A	49	1	X
2	2	R3017 Montant dommages B	50	1	X
2	2	R3018 Montant dommages C	51	1	X
2	1	D3006 Nombre d'occupants	52	2	X
2	C	R3021 Nombre de morts	54	2	N
2	C	R3022 Nombre de blessés graves	56	2	N
2	C	R3023 Nombre de blessés mineurs	58	2	N
2	C	R3050 Nombre de sans blessures	60	2	N
2	C	R3051 Nombre autres	62	2	N
2	1	D3019 État conducteur	64	1	X
2	2	R3020 Action conducteur	65	2	X
2	2	R3060 Taille conducteur	67	3	N
2	1	R3024 Âge conducteur	70	3	N
2	1	D3025 Sexe conducteur	73	1	X
2	C	D5002 Nombre de type 3	74	2	N

B.1 Fichier d'étude

Type d'enregistrement	Provenance 1=1ère partie 2=2e partie 3=Calculée	Variable	Position de gauche	Longueur (en caractères)	Type N=numérique X=alphanumérique
3	2	R4009 Code index	1	1	X
3	2	D4001 Numéro de partie	2	2	X
3	2	D4002 Numéro de fonction	4	1	X
3	2	R4003 Ceinture de sécurité	5	1	X
3	2	R4004 Numéro ass. maladie	6	8	X
3	C	R4008 Signe	14	2	X
3	C	R4007 Age à l'accident	16	2	N
3	2	R4005 Sexe	18	1	X
3	2	R1001 Taille de la victime	19	3	N
3	2	R4006 État de la victime	22	1	X

Collision location

5.2 Title: Évaluation du système de gestion de la circulation autoroutière de Montréal sur les accidents avec blessés et sur les délais d'intervention auprès des victimes d'accidents de la route [Evaluation of (the impact of) Montreal's freeway traffic management system on accidents with injuries and on response time in caring for accident victims]

Authors: Claire Laberge-Nadeau, Urs Maag, Antoine N'Zué Kouadio, Denise Desjardins and Stéphane Messier

Objectives

To verify the impact of the introduction of a freeway traffic management system in 1994 on the number of accidents, and on response time.

Data linkage, strategy and method

Using a record of accidents occurring in the municipalities along the two segments of freeway studied, the first task was to select the accidents that took place on these segments. One was our study segment, on which the traffic management system employing cameras and message boards was introduced in 1994, and the other was our control segment (no cameras or message boards). Incidents with victims were referred to Urgences-Santé (the emergency response service), which looked them up and provided us with the response times for the cases they found – about half, since not all victims are transported by Urgences-Santé. The traffic management system gave us data on traffic flow and, for several months following the installation of the system, the times of incidents as well (not just accidents, but breakdowns, objects falling from trucks, and so on). Linking these data was a tedious process, and most of it had to be done manually.

Results

Traffic flow on both segments increased on average by 2,600 vehicles a day each year (1991 to 1997). Accident rates on the study segment remained stable: 17.6 collisions per 10 million vehicle-kilometres before (1991-1993), compared with 16.8 after (1995-1997). There was a reduction in the rate of collisions with severe injuries, and the number of severely injured victims fell from 123 to 71, with a slight increase in the rate of collisions with minor injuries.

Median response times changed very little, but the longest times (90th percentile), did decrease.

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LABERGE-NADEAU C., MAAG U., N'ZUE A., DESJARDINS D., MESSIER S., Évaluation du système de gestion de la circulation autoroutière de Montréal sur les accidents avec blessés et sur les délais d'intervention auprès des victimes d'accidents de la route. Rapport d'étape #2 présenté au ministère des transports du Québec. 79 p., février 1999. [Evaluation of (the impact of) Montreal's freeway traffic management system on accidents with injuries and on response times in caring for road accident victims. Progress report No. 2 submitted to the Ministère des Transports du Québec, 79 pages, February 1999]

LABERGE-NADEAU C., MAAG U., N'ZUE A., DESJARDINS D., MESSIER S., Évaluation du système de gestion de la circulation autoroutière de Montréal sur les accidents avec blessés et sur les délais d'intervention auprès des victimes d'accidents de la route. Rapport d'étape présenté au ministère des Transports du Québec. 54 p., octobre 1998. [Evaluation of (the impact of) Montreal's freeway traffic management system on accidents with injuries and on response times in caring for road accident victims. Progress report submitted to the Ministère des Transports du Québec, 54 pages, October 1998]

6. SURVEY INFORMATION

Depending on the objectives of a research project, the study of existing administrative data and the extraction of variables that correspond to those objectives, it may occasionally be necessary to obtain complementary information through telephone or personal interviews, as it was for the survey on exposure to risk.

A survey may be an objective in itself, if the selection of the initial sample and of certain variables, such as accidents, is done by linking data. This was the case in the following example:

6.1 Title: La perception du risque d'être arrêté chez les camionneurs et les transporteurs routiers [Perception of the risk of being stopped among truckers and trucking companies]

Authors: Georges Dionne, Denise Desjardins, Marie-Gloriose Ingabire

Objectives

The main objective of the project was to evaluate the perception of the risk of being stopped among truckers and trucking companies. The second objective was to analyse the perceived severity of sanctions within the same group, the third related to the perception of the time taken for sanctions to be applied, and the fourth was to evaluate the consequences of misperceptions on road safety for truckers and trucking companies. The project is under way, and the results will not be known before the end of 2000.

Method

Base population

The base population consists of all trucking companies registered with the SAAQ that were still in business on December 31, 1998, had at least one vehicle of 3000 kg or more with an operating licence for 1998, and did not have an address expiry date on January 30, 1999[1]. It includes 40,726 trucking companies listed in table V_TRANSPORTEUR (see report on project 97-12 prepared by Dionne-Desjardins-Pinquet and submitted to the SAAQ in March 1999) on January 30, 1999, including 39,112 whose main sector of activity was trucking (that is 96% of the total population of trucking companies) and 1,614 whose main sector of activity was bus transportation (that is 4% of the total). These 40,726 companies used a total of 122,383 vehicles licensed to operate in 1998: 105,896 trucks and 16,487 buses.

[1] These two dates are attributable to the fact that the information comes from two different files: IMMAT98 and DOSPER, which were read on different dates.

List of telephone numbers to be canvassed by a survey firm

From the 40,726 companies, a random sample was drawn, and the telephone numbers were compiled. The sample included 2,142 trucking firms (3,000 kg trucks or over) and 414 bus companies (3000 kg or over). Note that the sample was stratified by fleet size in 1998 and trucking sector as of January 30, 1999.

In stratifying the sample, special attention was paid to large fleets in order to reach a sufficient number of large companies.

We shall not go into all the details of the method used (pretest, valid telephone numbers, and so on), as these are in the report. The research required a survey of trucking firms, followed by a survey of drivers.

Out of a target number of 1,000, the authors obtained 985 completed interviews with 499 trucking companies, 120 bus companies, 285 professional truck drivers, and 81 professional bus drivers. The telephone survey ran from May 5 to 31, 1999, after a pretest with some 40 trucking companies conducted on April 28 and 29, 1999.

In order to meet the objectives of the project, objective data from the SAAQ, such as violations, demerit points and accident involvement, were linked with the survey data.

6.2 Titre: L'exposition au risque, enquête exécutée pour le programme de recherche : "Impact sur la sécurité routière des normes médicales et optométriques pour la conduite d'un véhicule routier" [Exposure to risk: telephone survey for the research program "Impact on road safety of medical and optometrical standards for vehicle drivers."]

A telephone survey was carried out involving 20,206 holders of class 1, 2, 3, 4B, 4C and 5 driver's licences. In order to have a comparable basis on which to evaluate the driving records of those with a medical condition and those in good health, it is essential to have a measurement of exposure to risk. Such a measurement is often lacking in studies that seek to establish a relationship between a factor that supposedly contributes to accidents, and its impact on the

number of accidents. This is a serious omission, because exposure to risk has an impact on the number of accidents, even though there may not be a linear relationship between annual kilometrage and the number of accidents. Furthermore, holders of class 1, 2, 3 and 4C class licences do not necessarily work as truck, bus or taxi drivers.

Objective

If we wish to compare the involvement in accidents of drivers in the same class who are in good health with those who have a medical condition, exposure to risk is a variable that must be accounted for, although it is ignored in many studies.

Method

A questionnaire was prepared, and its validity tested. In preparing it, we surveyed the literature on the notion of exposure to risk. This led us to consider, in addition to what remains the most commonly used yardstick for exposure to risk – kilometrage – such other variables as duration of exposure, type of road used, time of day and certain kinds of driver behaviour.

The questionnaire was divided into two parts: one for respondents who drive a vehicle as part of their job, and the other for those who do not. For all respondents, the telephone interview began with an initial set of questions to determine which part was to be used.

To verify the degree to which the questions were comprehensible to various kinds of driver, and detect any problems associated with the use of the questionnaire, it was pretested with a group of 17 people. Three validation studies were also carried out with 40 bus drivers, 35 truck drivers and 32 class 5 (passenger vehicle) licence holders, respectively.

In addition to these validation studies, a survey firm was commissioned to carry out a pilot study of 800 holders of various classes of licence in order to identify the various stages of the main survey, and speed its execution. The pilot study helped us to 1) clarify the variables to be used in characterizing a person's driving record; 2) refine our method of obtaining telephone numbers and predict the time this would take for the main survey; 3) validate and revise the questionnaire

on exposure to risk; 4) ensure the reliability of the SAAQ/RAMQ medical record; 5) identify the small percentage of licence holders who drive as part of their job a vehicle matching their main licence class; and 6) obtain a competitive bid for the execution of the main survey.

Results

The results of the main survey were numerous and valid for the various classes of licence, in addition to serving as a control variable for the various analyses carried out for the objectives of this research program. For more information, see section 2.3 and the related bibliography.

7. THE CHALLENGES OF DATA LINKAGE

7.1 Demonstration of research applications

We have presented a number of examples of research projects carried out using sources of administrative data that could be linked. In our introduction, we cited other published research also based on linked data, particularly driver's licence records linked with the accident involvement of male and female drivers. However, we know of no other group that has carried out so much research, using so many linkages, of such complexity. We have demonstrated that these research techniques have produced new knowledge and original and even unexpected findings, such as the projects cited in 1.2, 2.2 and 2.3. Other projects have shown the risk factors applicable to road accident injuries, or have evaluated preventive measures, at relatively modest cost.

7.2 Administrative data and research data: an organization that facilitates their use

In Canada, the various federal and provincial government departments and agencies collect data on the entire population, particularly public insurance agencies: the health insurance agencies that exist in every province, and the automobile insurance corporations that operate in British Columbia, Saskatchewan, Manitoba and Quebec. The computerization of data on whole populations for administrative purposes is a routine activity for various government departments and agencies, and private companies. No one questions the pooling of data by insurance companies so that actuaries can make more accurate predictions of costs and life expectancy for

various groups, and adjust premiums accordingly. Yet there seem to be real difficulties in using existing data for research that can save lives and reduce human suffering.

Payment systems demand controls, and the production of data from beneficiaries, hospitals, doctors and individuals for compensation purposes. In a government department or agency, any branch may develop its own computer system which may well be incompatible even for internal administrative studies.

In Quebec, the SAAQ was given a legislated road safety mandate and an instrument it is constantly working to refine: the bureau of driver's licences and vehicle registrations, which offer opportunities to link data from various administrative databases using a unique number that facilitates the process. The SAAQ also makes its data available to researchers, and assists research with financial support through the FCAR and assistance to road safety research programs conducted along ethical lines. This did not just happen. The SAAQ's Research and Analysis Service is staffed by full-time experts engaged in research; from time to time, they are able to validate the results of university research by replicating them using new data. Furthermore, since this service's own activities enable it to recognize the difficulties that researchers face, it can act as an intermediary between university researchers and the administration. For example, Simard used new data to replicate the results of one of our studies of young drivers that showed an age effect on accidents that is distinct from the experience effect (see 2.1.5). These verified results have had an impact on SAAQ policies in the area of driver education.

At Transports Québec, since the creation of a transport safety branch, a core of expertise has been established, which can bring to bear on a given problem its data on infrastructure, road signs, accident locations and known danger zones, traffic flow and so on. The branch also serves as a link between academic road safety researchers and the Department.

In order to facilitate the use of linked data in road safety research, it is thus necessary to develop internal expertise in the organization and analysis of data that will at the same time serve the administrative needs of the agency, and facilitate the use of data that relate to a specific research

activity. For example, studies covering an entire population of drivers or vehicles will also make inferences easier.

7.3 A parallel with progress made in medicine, and police observations

Medicine made a great leap forward when doctors began to make careful patient notes, and this practice in time became mandatory. The medical files of a hospital must be centralized in its records department, which takes responsibility for organizing, codifying and circulating patient files, indexing diseases and so on. The purpose of all this is to track cases, review treatment and ensure quality care. The Mayo Clinic, established in 1908, was a trailblazer both in the quality of its clinical record-keeping and in the organization of its records with reviews and research that led to the description of new syndromes, new treatments, and their evaluation. In medicine, enormous progress was achieved when mandatory record-keeping was established for infectious diseases, cancers, and diseases the cause of which was unknown.

Yet in the case of a scourge as devastating as the injuries caused by traffic accidents, it is difficult to profit from the observations recorded for administrative purposes, and use them in research. Police reports exist only because of the legal proceedings undertaken to secure compensation for victims. These are semi-public documents that are regularly and almost automatically supplied to private insurance companies. Creating links between police reports and the notes on injuries in hospital records, however – this is simply not done. Is this a failure of medicine, or in the administration of justice?

In a "no fault" system, police officers are less often called upon to testify in court or at inquests, and take less care in the writing of their reports. Their unions engage in lobbying and pressure tactics to reduce their reporting obligations, and yet they are the first informed and trained witnesses to arrive at the accident scene immediately after a collision occurs. New technology is available to facilitate their work, and their written observations are very important.

7.4 Give and take in the exchange of knowledge and services

Users of data linked for research purposes also have an influence on the SAAQ: through the findings that affect their policies and programmes; through the quality of administrative data, which are often corrected; or through better organization of their files, which facilitates their own internal research and vice versa. The Dionne study made it possible to adjust the weighting of demerit points in connection with accidents. Ten years passed between the appearance of the initial results and the legislation that gave them practical effect. An evaluation study is now under way.

For our research into young drivers and driver education, a linked database was (in this case, laboriously) prepared by Fernand Pichette of the SAAQ, who carried out an internal study that we used in subsequent research that generated original results confirming those of other researchers in New Zealand (see 2.1.4, part I).

With experience acquired by University of Montreal and SAAQ researchers, studies using linked data are becoming increasingly complex, but remain feasible. For example, the study of cellphones and accident risks used not only SAAQ data from driver's licences, and data from a questionnaire, but also administrative data from four private companies.

7.5 Data quality

Obviously, the quality of a database depends on the quality of the information received and the quality of processing, particularly data capture. A technique often used by demographers consists in checking the quality of data by comparing it with other similar data. For example, Bourbeau (1976) compared traffic deaths as recorded by various sources: police data from the Ministère des Transports du Québec, data from the federal Department of Justice, and data from the provincial registry (death certificates). Although there are differences in the definitions of "traffic deaths" used by the registry and in police reports, Bourbeau found excessive variances, particularly in deaths reported by the Department of Justice.

Sometimes in a study accuracy is required if we need to rate the severity of injuries, or obtain injury diagnoses. In one case, the LST tried to get such information from death certificates. To our great disappointment, we found that most death certificates referred only to "multiple trauma", instead of providing specific diagnoses, and were therefore of no use in codifying injuries, despite the $600 search fee that was then substantial in relation to our modest research budget.

For one of our projects (see 3.1), we spent a year not only verifying the feasibility and developing the best method to adopt for an exhaustive survey of the literature, but also checking the quality of various data, including a telephone survey of seat belt use.

We checked use rates from our sample (police data) with road observations from Transport Canada and SAAQ surveys (spring and winter) over 3 years, and finally with data from our telephone survey. We were concerned about over-reporting of seat belt use in police reports, because of the legal requirement for front-seat occupants of cars to fasten their belts. We estimated about 10% over-reporting in police reports as compared with road observations. We accordingly decided to accept the data from police reports, assuming that a comparison of the injuries, or absence of injury, of belted and non-belted front-seat occupants involved in similar accidents could be valid but could slightly lower the effectiveness of seat belt use among occupants who did not use the belt but said they did. The validity of our results demonstrated the soundness of this reasoning.

On the other hand, the database used in this same project indicated a single injury diagnosis. For 100 cases, we checked this computer data against 100 manual files at the SAAQ; we found a 90% error rate for this variable and a lack of information on the various diagnoses for the injuries suffered by an individual. This study radically altered our method of gathering data: using the computer files for similar collisions, we listed the numbers for all 12,000 front-seat occupants in the vehicle or vehicles involved. We prepared a new file that included the necessary information on the circumstances of the accidents. To capture the injury data, we consulted the manual file and extracted all the diagnoses using ICD-9 coding, assigning an AIS-85 code to each injury and body area. Trained archivists captured the data on the 5,000 injury victims among the 12,000 occupants.

This also made it possible to compare the handwritten police report with the computerized data, correct certain capture errors and supply missing information using the non-computerized police sketch.

Some databases have limitations due to the time it takes to update them. For example, demerit points are entered only after a court has ruled, and in many cases, the records are not purged very often. Data on direct costs are very reliable, because of the insurance compensation. The SAAQ medical file suffers from under-reporting of medical conditions by licence holders. The prevalence of many medical conditions rises sharply at the age when a medical examination becomes mandatory!

Since it was established in 1978, the SAAQ (then the RAAQ) has constantly improved its records. Requests and recommendations from researchers have helped to improve the quality of its data.

In epidemiological research, we rarely have perfect data, and there must always be a concern to know whether its quality is good, adequate or sufficiently accurate to support valid research with a knowledge of the limitations of interpretation.

7.6 Technical considerations

Data linkage is relatively simple if there is an identification number common to all the records to be linked. If there are also a number of common variables, these can be used for verification. The SAAQ's records are well organized, and have identifiers that permit data linkage.

As soon as we have to deal with data belonging to different owners or services lacking strict coordination, linkage becomes more difficult. With common numerical variables, the job can still be done, but it is often necessary to use alphanumeric variables, like names or addresses. This is when linkage becomes more difficult, because of different spellings or abbreviations of the same name.

Access to modern high-performance computer equipment greatly facilitates data linkage. Transfers that used to be made from tape, and then from diskettes, are now made directly from one computer to another.

Researchers must have computer systems that can store and process large files. Multiple subfiles must also be created to study different issues and different subgroups.

Analysts must obviously know how to use powerful statistical software packages to process large files.

With the development of smart transportation systems, new data sources could become available for road safety research, if special attention is paid to these systems to make them usable for researchers. This a new avenue we should start to explore and plan for at once.

7.7 Ethical considerations

Data linkage for research purposes must be carried out in accordance with appropriate ethical rules. In research, individual data are used only to analyse groups. They can be rendered anonymous.

All owners of public or private databases are subject to rules of confidentiality. To link databases, we need a common identifier, which can be a number, so as to preserve the anonymity of individuals. Permission to access records for research purposes must be obtained from the access to information authorities.

The publication by Jeannette Montufar et al (1999) contains (on page 44) a table showing the information protection legislation of the various provinces, and some of the conditions applying to the use of data for research purposes are described. In general, for valid research purposes, access to and use of personal information does not affect the individual, and the benefits derived from research are in the public interest.

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